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TELEGRAPHIC COMMUNICATION WITH THE CAPE AND BERMUDA.

IN view of the critical state of European politics at the present time, the possibility of our entering upon a war, and the importance of maintaining our telegraphic communications with our Eastern possessions intact, Mr. Donald Currie, the extensive shipowner, has again drawn public attention to the question of connecting the Cape Colonies and also Bermuda by cable to England. Mr. Currie states his views in a letter to the *Times* of February 12th. Being of opinion that the Indo-European lines, running as they do through Russia, Turkey, and Persia, and also the Mediterranean cables, could be without difficulty interrupted by a hostile power, he advocates the advantages of an alternate route to India *viâ* the Cape. Such a route would be of great value in an Eastern or a Caffir war, and provided we could telegraph to the Gold Coast, St. Helena, and Simon's Bay, it would be of great service in controlling fleets. The subject was brought by Mr. Currie before Lord Carnarvon in 1875, and has recently been brought before Sir Michael E. Hicks-Beach, Lord Carnarvon's successor in office.

There is little doubt but that the Cape Colonies would willingly assist the Government in defraying the expenses of a West Coast of Africa cable from England to the Cape; but even then the cost would be likely to deter our Government from undertaking the work. Mr. Currie therefore proposes to connect the island of St. Vincent, in the Cape de Verds, with Goree, a West Coast settlement, at which the mail steamers bound for the Cape could call instead of at Madeira, and by this plan the Cape would be brought within eleven or twelve days of England. An extension of telegraphic communication to the whole of the British West African settlements would, he thinks, be of immense value to the nation, both navally and commercially, and he regards an African East Coast line between the Cape, Mauritius, and Aden, as an imperial necessity. Mr. Currie also draws attention to the fact that we have no cable communication with Bermuda, the winter headquarters of our North American and West Indian squadrons, and the only place at which we have a floating dock. At present our only means of corresponding with Bermuda is by the fortnightly steamer from New York, or the monthly one from Halifax. Cables from England to Bermuda, and from Bermuda to Jamaica, in conjunction with the African coast cables proposed, would bind all our naval stations together.

Although this system proposed by Mr. Currie is highly desirable, yet when we consider the enormous outlay it would involve, and the uncertainty of the return, we cannot but agree with Sir James Anderson, that it would not be advisable to scatter submarine cables in any such "broadcast manner." Nevertheless there is a good deal to be said in favour of certain parts of the scheme. A cable from England to Bermuda for instance, supplemented by another from Bermuda to New York rather than to Jamaica, is no new project. The present Brazilian cables were originally intended for this line, and it would not only be of imperial service, but in all probability a commercial success.

Sir James Anderson estimates that to connect St. Vincent with the Cape, *viâ* the West Coast settlements, would take 6,000 miles of cable, and to connect St. Vincent with the Cape, *viâ* Ascension and St. Helena, would take 4,500 miles. The latter cable would be laid in water from 2,000 to 3,000 fathoms, and in the course of the south-east trades. It would, therefore, be difficult to maintain, and Sir James is of opinion that no tariff could be established which would develop a traffic to make it remunerative. Although we admit the St. Helena route is open to these grave objections, we think the Coast route is much less so. By keeping closer to the Coast, so as to connect up the West Coast settlements, there is more likelihood of developing commerce and obtaining traffic, while the water is shallower and the region of constant trades is exchanged for that of variable monsoons. Of the two western routes we would, therefore, give the preference to that along the coast, although it might be fifteen hundred miles longer. There may not be at present sufficient commerce to justify the expense of laying so long a cable, but the recent discoveries of Stanley are certain to give an impetus to West African trade, and it will not be many years before such an undertaking will be warranted.

The need of a cable, connecting the Cape colonies to Aden, *viâ* the East African coast settlements, Delgoa Bay, Mauritius, and Zanzibar, finds more favour in the sight of Sir James Anderson. Owing to the growing commercial activity of these places, the connection of Aden to the whole world by the Red Sea and Indian Ocean Cables, and the fact that a tariff "unimportant as compared with any that could be arranged by the proposed Atlantic route" could be established, he is of opinion that the east coast route offers by far the greatest advantages. As a purely commercial speculation it undoubtedly does, but if we understand Mr. Currie rightly it is quite as much as an imperial one that he treats

the question. His wish is to have the advantage of an alternate route in case the Mediterranean cables should be interfered with. Sir James thinks that the "unquestionable advantage of alternate routes" should be sought in some other direction than the West Coast of Africa, and contends that they can be multiplied along the "course which commerce has already selected," viz., the Mediterranean and the Red Sea. We do not quite see how an additional line along the old course can properly be called an alternate route; nor how it can well be considered as a security if that route is open to attack. It appears to us that an alternate route is properly one in a different part of the world which may be safe, although the other is menaced or interrupted. However, in the words of Sir James, "this subject, in part, has already been submitted to our Government, and there we will leave it."

SIEMENS' APPARATUS FOR RECORDING ELECTRIC TELEGRAPH SIGNALS.

THE object of this invention is to enable signals to be recorded by very weak currents, as in Sir W. Thomson's Siphon Recorder. Like the instrument just mentioned, the apparatus of Messrs. Siemens traces a continuous straight line on a paper strip so long as there is no current passing through the circuit, and this line is made to deviate to the one side or the other, according as a positive or a negative current is passed through the instrument. The means by which this is effected is as follows—

The paper strip has its surface on which the style acts blackened with finely divided carbonaceous matter, such as that deposited from smoke, so that as it is passed under the style the point of the latter, by removing the carbon along its line of contact, produces a white line (or of the same colour as the paper) on the blackened paper. For the purpose of blacking the paper it is passed over a smoking flame, and to prevent it from being ignited or charred, it is, during its passage over the flame, kept in close contact with a cylinder of metal or other good conductor of heat.

In order to fix the carbon coating on the paper strip after the line or signal has been traced thereon, so as to render the record permanent, the paper strip is treated with alcohol, ether, or other liquid, in which some resinous or glutinous substance is dissolved, it being for this purpose passed under a cylinder which dips into a bath of the liquid; and in order to accelerate the drying of the paper strip after it has been so treated, it may be passed over a wire gauze or other surface heated by a flame.

The movements of the style may be produced in any known manner. It may, for example, be attached to the tongue of a relay, or to a coil suspended in a magnetic field, as in Sir W. Thomson's instrument.

Messrs. Siemens also work the style by a coil in a circular magnetic field, which coil, for the sake of

Fig. 1.

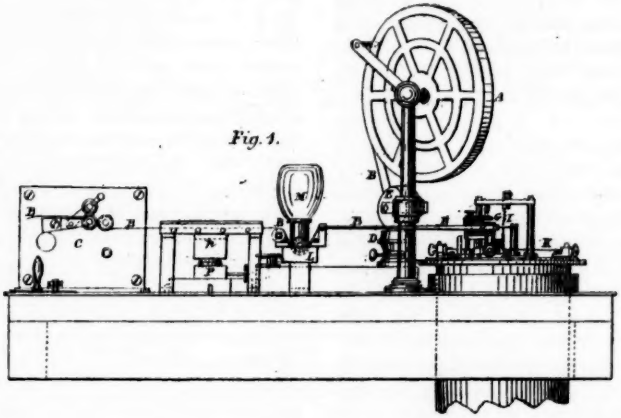
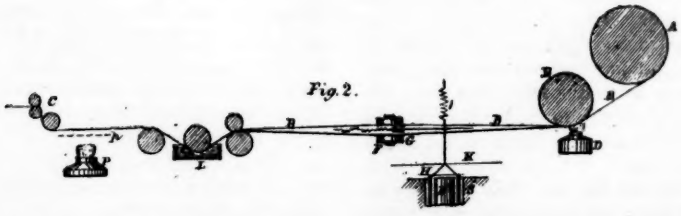


Fig. 2.



lightness, is made of aluminium. It is suspended by a spiral spring, and in order to bring the coil rapidly back to the position of rest, and to prevent its lateral oscillations, elastic strings are stretched horizontally through the point at which the coil is attached to the spring, these strings serving as conductors for the coil.

Fig. 1 represents a general, and fig. 2 an outline view of the instrument. A is the reel whence the continuous paper strip B is drawn by the ordinary clockwork C. The paper B in its course from the reel A first passes over the smoking flame of a lamp D, above which is mounted the metal roller E, to prevent the over heating and scorching of the paper. The paper then is led over a roller F, between it and the tracing style G, which is attached to the bobbin H, of aluminium wire, suspended around the pole of the magnet N by a helical spring I.

In order to centre and steady the bobbin, two cross wires, only one of which, K, can be seen in the drawing, stretched by adjusting screws, are attached to it, and these wires serve as conductors. When electric impulses are transmitted through these and the coil of the bobbin, the latter is caused to move upwards or downwards in the magnetic field, and the traceing point G attached to it marks on the blackened paper B a wave line. From the roller E the paper is led under another roller through a vessel L (fig. 2) containing fixing liquid, which vessel is kept charged by a fountain glass M. The paper having been thus moistened is dried by being passed over the flame P of a lamp between which and the paper there is a screen *p* of wire gauze.

ON STRATIFIED DISCHARGES FROM A CONDENSER OF LARGE CAPACITY.

By WILLIAM SPOTTISWOODE, M.A., LL.D., Treas. and V.-P. of the Royal Society.

THE principal object of the following communication is to describe an instrumental arrangement which has proved very convenient for the production of steady striæ. The first attempt which was made nearly two years ago (February, 1876), consisted in charging a Leyden battery of nine large jars by means of an induction coil, and discharging it gradually through a vacuum tube. This was effected by connecting one terminal of the tube with the outside of the battery, and presenting the other terminal, made pointed, to a knob connected with the inside, at suitable instances. The following effects were then observed :

(1.) When the interval between the terminal and the knob was considerably greater than striking distance, the appearance in the tube was cloudy and apparently unstratified, or showed only faint indications of stratification. It was, in fact, very similar to that produced by attaching one terminal of the tube to one of an induction coil, and carrying the other to the earth.

(2.) When the interval was within striking distance, the usual jar-discharge without stratification or dark space took place.

(3.) When the interval was slightly greater than striking distance, but not so great as in the first case, a bright stratified discharge was observed. The proper motion due to a decline in tension was shown by a revolving mirror, and by a careful but rapid alteration in the distance during discharge, the motion could be arrested or even reversed. The duration of the whole, although long compared with a single flash from an ordinary coil, did not exceed half a second.

This experiment gave reason to hope that if a condenser of sufficient capacity were constructed, the discharge might be prolonged, and even varied, so as to allow an actual study of its various phases to be made.

The next attempt was made during last summer with some condensing plates, constructed for cable purposes, and kindly lent by Messrs. Latimer Clark, Muirhead, and Co. The results were in every way calculated to encourage further steps.

At the suggestion of Mr. De la Rue, and with the assistance of his battery for the purpose of testing the instrument, the same firm constructed for the experiments condensers of which the following are the particulars. Each condenser is contained in a box, and has a capacity of 13·8 microfarads, subdivided into ten sections, each section containing forty sheets of tinfoil, 18 in. by 13 in., insulated from each other by eight sheets of paraffined tissue paper. The superficial area of foil in each box is 1,300 square feet, and that of paraffined paper 14,166 square feet. It was found that these condensers could easily be charged with a 4-inch induction coil, worked by two Grove's, or even bi-chromate, cells. A much smaller coil would certainly suffice if the coil were made with a thick secondary, since ¼ to ⅓ inch sparks are all that are required. In order to charge the condenser, one terminal of the coil was carried to outside of the condenser, and the other to the other with an intervening air spark. The object of the air spark was twofold : first to ensure that the tension of the electricity was sufficient to give the required charge to the condenser ; and, secondly, to prevent the latter from discharging itself back through the secondary of the coil. After some trials, it was found that the air spark might with great advantage in steadiness of action be replaced by a vacuum-tube which offered sufficient resistance : such, for instance, may generally be found among those prepared for spectrum analysis, although these differ very widely in resistance. Lastly, the condenser was furnished with a safety discharger, consisting of a brass sphere and a point adjustible in distance from one another, so that the condenser might discharge itself at a suitable tension ; *i.e.*, before the tension rose high enough to break down the insulation of the plates.

The discharge through the vacuum tubes on which experiments were being made was effected either by leading the two sides of the condenser directly to the terminals of the tube ; or more often by leading one direct, and the other through the intervention of a resistance coil, such as was described in the Proceedings of the Royal Society for 1875, pp. 461-2. By altering the length of the resisting column as the tension in the condenser declined, the charge could be delivered through the tube at any required rate.

By this arrangement a steady stratified discharge can be maintained for one, two, or more minutes, according to the nature and pressure of the gas contained in the tube. In one case a nitrogen tube of 30 inches in length and 2 inches in diameter, a

special fixed phase was maintained for upwards of five minutes with one of the boxes above mentioned.

Speaking in general terms, the same connection between resistance in the circuit and the flow of the striæ as had previously been noticed with the induction coil and rapid contact-breaker (Proceedings of the Royal Society for 1875, pp. 458-9), was observed with this method; but the phenomena were exhibited with greater distinctness, and could be examined more at leisure.

In particular, with the nitrogen tube above mentioned, and other similar tubes, the direction of the flow reversed itself as the charge in the condenser became more exhausted. This was apparently due rather to a diminution in strength of current, or quantity of electricity passing through the tube, than to fall in tension, inasmuch as any particular phase could be maintained by gradually diminishing the resistance in the circuit as the tension declined. The penultimate phase was a forward flow from the positive terminal the ultimate a fixed condition of striæ. When sufficient resistance was interposed in the circuit, these striæ showed a faint indication of fissure into pairs of laminæ, and even actually broke into pairs by forward jerks. Very shortly after this the column became blurred, and the discharge then finally ceased. It should be further mentioned that by a suitable increase or diminution of resistance in the circuit the flow could be reversed again and again at pleasure.

It has frequently been noticed that in some tubes the column of striæ shows a tendency to mobility, while in others it is comparatively fixed; in one case it appears to be in a position of unstable, in the other in a condition of stable equilibrium. The former may generally be exemplified in hydrogen and nitrogen vacua, the lattter in carbonic acid, hydrochloric acid, and other vacua. Experiments recently made with another, in some respects yet more powerful method, tend to bring out the connexion between these two classes, an account of which is reserved for a future occasion.

Pursuing this subject further, the same experiments were repeated with an 18-inch, instead of a 4-inch coil, using as a battery either six large bichromate of potash cells, or, with still better effect, a large Gramme's machine, worked by steam. The results were in every way satisfactory. Tubes in which with the 4-inch coil the striæ were at best only imperfectly developed, or in which it was impossible to maintain the discharge for any finite time, were illuminated successfully in both respects; and in many cases the supply of electricity from the coil to the condenser could be so regulated as to maintain special phases for an indefinite time. The change of tint from pale salmon colour to violet gray in (impure?) carbonic acid vacua, due to increased tension, as observed by Mr. De la Rue, with his great battery, were here displayed with great brilliancy.

The advantage of the 18-inch over the 4-inch coil consisted not so much in the tension as in the quantity of electricity given off to the condenser at each secondary discharge; and it seems probable that a coil specially constructed with very thick primary and secondary, and capable of giving sparks from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length, would be the most suitable instrument for the purpose. It would, of course, be necessary that the condenser should have sufficient capacity to act as a fly-wheel during the intermittance of the supply from the coil.—*Proceedings of the Royal Society.*

HASLER'S ELECTRIC WATER-LEVEL INDICATOR.

THE electric water-level indicator, which had been fixed in 1869 to connect a reservoir on the Könizberg, with the gas and waterworks of the town of Berne, but which is no longer in use in consequence of the removal of these works, has worked well for seven years. However, its maintenance presented great difficulties in consequence of the extreme length of the double conduit (about a league), and from the nature of the mechanism establishing electric contacts. Of the 100 branches of the conduit, many were already in a bad state in the second year, and their failure caused derangements in the working of the apparatus, and the indicator gave false indications if the water-level changed during a repair. Also with the contact system employed, the current (furnished by 20 Meidinger cells) was liable to remain closed for several hours, and even days, when the water-level did not vary, and in consequence the battery would be hard worked. A battery which was employed at Berne to work 70 electric clocks, and the circuit of which remained closed for about 10 seconds every minute, had to be renewed every eight days, whilst a similar battery, employed in a hotel to work electric bells, did not require refreshing oftener than once in one or two years.

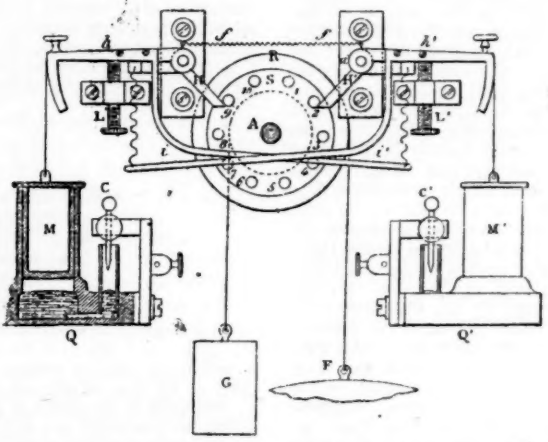
In order to avoid this continued contact inconvenience, M. Hasler has adopted for the new water service of Berne and of Lausanne (which takes its water from Lake Bret, distant about four leagues), a system in which contact is only made for about one second each time the water-level rises or falls by a certain fixed quantity; this system is shown by Fig. 1. On the axis A, behind the back part of the apparatus, is fixed the wheel R, to this is suspended the copper float F; the wheel has a circumference of 0m.30, so that when the float sinks 0m.30, the axis A describes one revolution; when the float rises the axis turns the opposite way by means of the counterpoise G, which is suspended to a second wheel rather smaller than the first, but fixed on the same axis. In front of the first wheel there is a disc S, with 10 small pins, which act, when the axis is rotated, like the buttons or stops of the bell of a clock; but, whilst in a clock the wheel which carries the stops acts constantly in the same direction in order to lift the arm to which the hammer is attached, in the present instance there are two arms, H and H', which are severally acted upon according as the disc S turns in one direction or the other.

Upon an axis *a* moves a lever H' with two arms, of which the left arm can be raised or depressed by the pins during the rotation of the disc. The right arm of the lever presses against a second lever *h'*, under the influence of the spring *f*. The lever *h'*, which also moves upon the axis *a*, normally rests on the adjusting screw L'. A hollow brass cylinder, M', is suspended at the extremity of the lever *h'*; Q' is an iron reservoir filled with mercury, and furnished

with two tubes communicating with one another, in the larger of which moves the cylinder M', whilst the small one, formed of a straight glass tube, receives an insulated point C', which serves to establish contact, and which is above the level of the mercury.

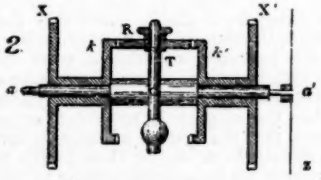
When the level of the water falls so that the float descends a distance of m.003 the disc S turns, the left arm of the lever H' is pressed by one of the pins, the lever *h'* is lifted at the same time with the cylinder M', until the pin (2) escapes from the lever H', and then the system of levers returns to its normal position. When the cylinder M' falls, the air is compressed in the large tube, the mercury rises in the glass tube, contact is established for a moment, after which the mercury falls. If the float descends another m.003, a second contact is made, and so on.

Fig. 1.



When the disc S turns the other way, that is when the float rises, the left branch of the lever H' is lifted each time until it falls back to its normal position; but the lever *h'* remains unmoved. At the

Fig. 2.



same time, when the float rises m.003, the lever H and *h* are lifted, and contact is established in C by means of the cylinder M.

When the level of the water rises or falls within the limit of m.003, the cylinders M, M' move so very gently that the air cannot become compressed, and consequently contact cannot be established either at c' or c.

In order to make the action of the apparatus certain, it is necessary, when the right lever falls back, that the left one should be brought again exactly at the same moment to its normal position. To obtain this requirement the arm of the lever, lifted up each time, moves rather more than the opposite arm, which is pressed down at the same time by one of the pins. The two crossed arms *i*, *i'*, are fixed to the levers *h*, *h'*; the end of the arm *i'* is connected with the lever H' by a cord, and the end of the arm *i* in a similar way, is connected to the lever H. When a pin (2) depresses the arm of the lever H', the lever H is lifted at the same time by another pin (9); before the first pin (2) descends, the arm of the lever *i'* begins to act, and lifts the lever H above the pin (9) to a height such that when (2) descends the lever H can fall back in its position of rest in front of the pin (9).

The indicator which shows the level is the same as that of the electric level of Siemens and Halske; on the axis *a*, *a'* of the needle Z (Fig. 2) two crown wheels, X, X', are attached to two ratchet wheels, *k*, *k'*, whose teeth are turned in opposite directions; these two former wheels gear with a wheel R running loose on an axis T, which traverses *a*, *a'*; so that one of the electro-magnets through which one current passes turns the wheel by means of an anchor escapement in one direction, whilst the propelment of the other magnet turns its wheel in the opposite direction, and the wheel R can thus be made to turn the axis *a*, *a'* and the needle Z to the right or left.—*Musée de l'Industrie Belge.*

ON THE INTERPRETATION OF SOME EXPERIMENTS (OF FARADAY'S) RELATING TO THE INDUCTIVE EFFECT PRODUCED BY THE ROTATION OF A MAGNET ON ITS AXIS *

By S. TOLVER PRESTON.

1. A CURIOUS and interesting question is raised by some experiments of Faraday, described in the "Philosophical Transactions" in regard to the inductive effect attendant on the rotation of a magnet

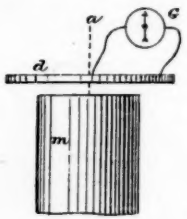
* From the *Popular Science Review* for January, by permission of the Author.

that experimental results rendered it necessary to draw a distinction between the motion of *rotation* and the motion of *translation* of a magnet, in regard to the behaviour of a system of force about it; for he says (Phil. Trans. 1852, p. 31.), "When lines of force are spoken of as crossing a conducting circuit, it must be considered as effected by the translation of a magnet. No mere rotation of a bar magnet on its axis produces any inductive effect on circuits exterior to it. The system of power about the magnet must not be considered as revolving with the magnet, any more than the rays of light which emanate from the sun are supposed to revolve with the sun. The magnet may even, in certain cases, be considered as revolving among its own forces and producing a full electric effect sensible at the galvanometer."

At the first sight it will appear theoretically a strange conclusion (and Faraday, himself designates it afterwards as "singular") that the above distinction between a motion of rotation and a motion of translation should hold. For even if we take the above illustrative case of the sun it must appear evident (as regards the light emitted from any luminous portion of the sun) that any effect that was produced by the translation of that luminous portion through space would equally be produced by the rotation of that same portion about the axis of the sun, for rotation *is* simply *translation in a circle*. So by the rotation of a magnet on its axis, its constituent parts are *translated* in circles. It would therefore seem necessarily to follow theoretically that any law that applied to the translation of a magnet would equally apply to its rotation. It is an observed fact that by the *translation* of a magnet, the inductive effect produced on external conductors is precisely the same as if these conductors were themselves translated with the same relative velocity past the stationary magnet, or the effect simply depends on relative motion. It would therefore seem a necessary influence that the effect by the rotation of a magnet also depended on *relative* motion, or that the inductive effect on any external conductor would be the same whether the conductor were moved past the periphery of the magnet, or the periphery of the magnet were (conversely) moved with the same relative velocity past the conductor (by the rotation of the magnet on its axis).

Faraday, however, appears to have considered that experimental results opposed this inference, for he concluded (as stated in the above quotation) that while the rotation of the conductor about the magnet produced an inductive effect on the conductor, the same relative motion of the magnet to the conductor (when the magnet rotates on its axis) produced no inductive effect on the conductor. The experiment on which this conclusion was grounded was as follows (Phil. Trans., 1832, p. 183):—

A circular disc of copper *d* was rotated on its axis *a* above the pole of a cylindrical bar magnet *m*. A wire *w*, in whose circuit a galvanometer G was placed, had one end maintained in sliding contact with the edge of the disc, and the other with the centre of the disc. It was found that the current given off by the rotation of the disc, and passing through the wire *w*, was precisely the same whether the magnet *in addition* was rotated on its axis in either direction, or remained stationary. Hence it was concluded that the rotation of the magnet on its axis produced no inductive effect on the disc, or (generally) that a rotating magnet could produce no "inductive effect on conductors exterior to it." Faraday adds, after a second perfectly similar experiment to the above, with a cylindrical copper cap instead of a disc (p. 184): "Thus a singular independence of the magnetism and the bar in which it resides is rendered evident." In other words, it was inferred that the system of force about the magnet could not be regarded as partaking of the motion of the magnet and crossing external conductors, when the magnet rotated on its axis. It will be observed that this necessarily involves the conclusion that, although the system of force emanating from the periphery of a magnet *admittedly* shares the motion (so as to cross external conductors) when the periphery is moved in the act of *translation* of the magnet, yet that it does not do so when the periphery is moved in the act of rotation of the magnet on its axis. It is difficult to see how this conclusion could be theoretically consistent, for what distinction can be logically drawn between



a motion of rotation and one of translation in this case, as by the rotation of a magnet on its axis its periphery is *translated* in a curve, and evidently a different law could not apply to the behaviour of a system of force according as to whether it is translated in a curved or a straight line. We should have considerable diffidence in criticising anything put forward by so eminent an authority, but scientific truth is admittedly paramount, and no one would claim immunity from an oversight. We think it may be distinctly shown that the above is an oversight resting on the rather curious accident that the particular experiment tried admits of a *double* interpretation. Thus, if we make no distinction between the behaviour of the system of force, whether the magnet is translated or rotated, or asssume that the system of force is invariably at rest *relatively to the magnet*, then by the rotation of the magnet on its axis the system of force accompanying the magnet will cross *both* the wire *w* and the disc *d*, thereby tending to generate a current in them both in opposite directions, so that there will be no current at all. This is therefore why the magnet, when rotated in either direction, produces no difference in the results. The final result is the same, not because the rotating magnet produces no inductive effect, but because the inductive effects upon the wire and disc *oppose* each other; or the rotating magnet causes an electric disturbance both in the disc and in the external wire in such a way as to produce a balanced static charge, so that no current is possible. To prove that the inductive effects in

on its axis. Faraday appears to have considered the disc and wire exactly balance each other, it is only necessary to rotate the wire and disc together through the lines of force of the stationary magnet, when there will be (as is known) no current in the circuit made up of the disc and wire, the effects in the disc and wire therefore exactly opposing each other. So, therefore, it becomes clear how the rotation of the magnet on its axis can make no difference in the results; and, therefore, the experimental result does not warrant the above singular distinction drawn in regard to the behaviour of the system of force when a magnet rotates on its axis.

Notes.

IT appears to be the inevitable fate of every "effete Britisher" who visits the United States of America, to become enthused over the "Institootions" of that great country. Pullman cars and monster hotels whirl away his self-possession, gin-sling and brandy smash take away his breath, the very Genius of Go-aheadism gets into his brain, the free air of the Rocky Mountains vivifies his blood, and the eloquence of Col. Jefferson Brick flows from his tongue. We still remember the eminent example of this amusing Yankee-mania, as we may call it, which was afforded us by Sir William Thomson, on his return from the Centennial Exhibition at Philadelphia in 1875. Sir William, as president of the Physical Section of the British Association, delivered the opening address to that section soon after his arrival home, and while he was still under the spell of America. The mind of the great physicist was evidently on the horns of a dilemma. While on the one hand it was labouring to produce a theory of the earth, on the other, it was struggling to give vent to the "big things" it had just seen across the Atlantic. The result was a remarkable production, whose head bristled with Yankee notions, and whose tail was composed of a profound dissertation on the rigidity, sphericity, fluidity, elasticity, and quasi-plasticity of the globe. Similarly at the meeting of the Telegraph Engineers on Wednesday, Feb. 13, Mr. W. H. Preece, in a lecture on "American Telegraphy," evinced that he too had caught the American infection, and the issue was a racy and entertaining discourse, in which the statistics of telegraphic progress were pleasantly interfused with tender memories of cock-tails and reminiscences of Niagara. Some of the specimens of American telegraphic terms which Mr. Preece drew attention to, were less calculated to excite our admiration than the practical novelties. We shall be happy to receive as many new instruments as our cousins can send us, but we must all wish that a kind providence may protect us from their nomenclature.

TELEGRAPHIC communication between Constantinople and Odessa, has been restored by the repair of the Black Sea Company's cable. The Turkish overland lines being occupied by the urgent interior correspondence of the Government, communication by this cable affords a direct service between England and Constantinople.

A MEMORIAL, signed by leading firms in New York, Philadelphia, and Boston, who are not in any way interested in existing telegraph cables, has, we are informed, been presented to both Houses of Representatives, asking Congress to secure the utmost facility of telegraphic communication between the United States and the rest of the world, by rejecting all applications for exclusive privileges, and passing a law giving permission to all persons and companies, without preference, to land telegraphic cables on the shores of the United States, and through them maintain telegraphic communication between the United States and other countries.

THE cable between Singapore and Batavia is interrupted, so that telegrams for Java, Australia, and New Zealand are, for the present, subject to delay. They are being forwarded by a steamer between the points of interruption.

THE West India and Panama Telegraph Company's repairing ship *Investigator* has successfully accomplished the laying of the new cable between Santiago de Cuba and Jamaica, thus duplicating that section of the company's system. The cable was manufactured by Messrs. Siemens Brothers, Charlton, and is reported to be in perfect electrical condition.

THE Great Northern Company's Cable between Nagasaki and Shanghai is restored. Messages are again received from all stations in China and Japan.

THE ELECTRIC LIGHT.—Some gunnery trials by night were recently made at Metz by help of the electric light, and under the surveillance of a committee of German military officers. Strong lights placed at a considerable distance from the targets rendered them distinctly visible even during a thick fog, and enabled the gunnery practice to be carried on successfully. It was found possible to light up small detachments of men out of rifle shot so well that artillery fire could be directed upon them. It is believed that the electric light may be made very useful in siege operations.

A SKATING rink at Hankley has been illuminated by the electric light.

THERE was great excitement all night long in the Place de l'Opéra last night. The experiments that have been some time in progress for lighting the exterior of the Opera House with the electric light were extended to the entire place. Eight lanterns, considerably larger than the gas lamps in ordinary street use, have been

erected on the Place de l'Opéra, four being on each side of the Boulevards. Beneath each of the larger lanterns are four smaller lamps, probably intended for service in the event only of some accident happening to the others. At all events, the latter were not lighted. The illumination from the eight lamps, and from the six small globes which have been on trial, was sufficient to make the neighbourhood of the Opera almost as light as day. The gas from the cafés and from the advertisements of various public amusements, which have hitherto made this the brightest spot in Paris, looked yellow and dull by the side of the pure white electric light. The ground glass of the new lanterns prevents the beams from being in the least dazzling, and there is none of that solution of continuity in the radiance which has been observed hitherto in all electric illumination. As midnight approached, the time for opening the doors of the Opera, crowds began to assemble, and the doorways soon became impassable, so dense was the throng of people who, attracted by the new experiment, waited to watch for the arrival of the maskers. To say sooth, these were few in comparison with gentlemen in ordinary evening dress, and ladies in black dominos and long mantillas. Nevertheless, the general effect viewed from the top of the grand central staircase, which is the glory of the building, was brilliant in the extreme; the bright colours of the fancy dresses standing out in splendid relief from the richly-hued marbles, and the rapidly-moving groups giving animation to the imposing scene. —*Daily Telegraph*, Feb. 18.

THE S.S. *Monarch* before leaving for the East is to be fitted with an electric light for torpedo work capable of sweeping the sea for three miles round.

THE Edison Phonograph was recently exhibited publicly to a crowded assembly in New York. The sounds produced by it were heard and understood in different parts of the room, especially those spoken with emphasis, and in a high key. Different voices were readily distinguished, and snatches of songs were reproduced with wonderful fidelity. The inventor confidently expects to perfect it, so that the performances of the best vocalists may be faithfully delivered by it at second-hand.

SIR WILLIAM THOMSON, in bringing the phonograph before the Royal Society, Edinburgh, recently, alluded to it as an elaboration of the electric pen. It appears to be a union both of the telephone and the electric pen.

TELEPHONIANA.—We hear that Mr. Spottiswoode finds that the telephone is audible without any diaphragm if the end of the magnet be placed close to the ear.

M. A. DEMOGET, of Nantes, contributes some further facts about the telephone. If one speaks into a telephone in circuit with the primary coil of a Ruhmkorff coil, the sounds can be distinctly received on a telephone in circuit with the secondary coil.

In order that the sounds transmitted by the telephones should be more easily perceptible, it is necessary that the plates should vibrate, as nearly as possible, in unison with the sounds emitted. This explains why the voices of women and children are best heard with vibrating plates from 3 to 5 centimetres in diameter, and the voices of men with plates from 6 to 8 centimetres in diameter. If the scale is sung into a telephone with a large vibrating plate, the first low notes will be easily heard, whilst the more elevated will be less distinct; if the vibrating plate is of small diameter the contrary will be the case, the most elevated notes will be most distinctly heard.

Two telephones can be put in a double circuit at one extremity of a line, and if a person speaks or sings into the two instruments simultaneously both voices will be heard in a single telephone at the other extremity of the line.

If in front of and at the distance of a millimetre from the vibrating plate of the telephone, we place one or two similar vibrating plates, taking care to pierce at the centre of the first one a circular hole of a diameter equal to that of the magnetised bar, and in the second a hole of greater diameter, not only the intensity of the sounds, but their distinctness will be increased thereby. By this means the vibrating mass is enlarged and the undulatory currents are intensified.

IN the *Comptes Rendus* for February 4, M. L. de Champvallier relates another instance of telephonic echoes similar to that recently reported from Providence, U.S. It appears that at Clermont, in France, there are two short telephonic lines, a line fifteen kilometres long from the summit of the Puy de Dôme to the Observatory of Clermont, and another fourteen kilometres long from Clermont to the village of Fontaine-du-Berger. These two lines are carried for ten kilometres on the same posts, being at a distance of at least eighty-five centimetres from each other. When speaking is carried on over the Puy de Dôme line, it can be overheard so distinctly, that it can be told whether it is a man or a woman who speaks, and even the words can be understood at times. It has been remarked that the messages sent from the Puy de Dôme are much more audible than those sent from Clermont, but this is probably due to the peculiarities of the voices of the speakers, or to the relative position of the stations.

M. NIAUDET proposes to use the telephone as a detector of extremely feeble currents, by means of an induction bobbin. The current is to be sent through the primary coil of the bobbin, and the telephone is to be in circuit with the secondary coil. If now the primary circuit be rapidly interrupted, the feeble current will give rise to sounds in the telephone.

AT a recent meeting of the Royal Institution, Mr. Warren de la Rue, vice-president, stated that from experiments he had made, he came to the conclusion that the ordinary telephonic currents were feebler than the current from a Daniell cell through one hundred megohms resistance.

THE Hon. Rollo Russell finds that for short distances, it is not necessary to insulate a telephonic line. Articulation and the tunes of a small musical box were heard by him over an uncovered copper wire circuit, laid four hundred and eighteen yards along the grass, the going and returning wire being kept well apart. Even when the wire was buried in wet clay for twenty yards, or immersed in the water of a pond for forty yards, talking in a low voice could be carried on without any appreciable loss of the effect obtained when insulated wires were employed.

MR. F. J. M. PAGE, of the Physiological Laboratory, University College, finds that when the telephone is in circuit with the primary coil of a Du Bois Raymond induction coil, while the secondary is in circuit with a Lippmann's capillary electrometer, movements of the mercury column are found to accompany every word spoken into the telephone. It was found that the movement was always toward the capillary end of the electrometer tube, no matter in which direction the telephonic currents passed through the mercury; but this was proved to be due to the fact that the mercury tended to move *quicker* when a current passed towards the point of the capillary, than when it passed in the contrary direction, so that when a succession of undulatory currents is passed through it, the mercury moves towards the point in the capillary, its movement away from it being masked by its relative sluggishness in that direction. See the proceedings of the Physical Society in this number.

ON Thursday the 21st. ult., Mr. Childers asked the Postmaster-General whether his attention had been called to the use of the telephone by telegraph departments and companies abroad; and whether it was his intention to introduce it into the postal telegraph service. In reply, Lord John Manners said that the use of the telephone had been brought under his notice, and an inquiry into its merits had been made by the officers of the Post Office. The results, however, were such as to render its use, at present, unsuitable for the postal telegraph service.

AN ELECTRICAL STORM IN CALIFORNIA.—A correspondent of our American contemporary, the *Operator*, writes as follows:—An unprecedented electric and sand storm has visited this portion of the country (Tulare, Cal., Jan. 18.), entirely prostrating the wires of the S.P.R.R. at and around this place. The storm was of over three hours' duration, lasting from eleven a.m. until two p.m., during which time lamps had to be lighted, it being impossible to distinguish the outlines of the ox car six feet away. The air during the storm was so thickly impregnated with electricity, that one received a slight shock on merely grasping hands. On the approach of the storm, which could be heard several miles away, we cut out the instruments and disconnected the office connections leading from the main lines, but that proved a failure as regards obstructing the electricity, as the minute the storm struck, the cut outs emitted a crackling sound, followed by sheets of flame three inches in length from the cut out points. Some of these jumped from the cut out to the instruments, a space of over seven feet, and partially fused the instruments. On going into the freight house, the roof was discovered to be on fire in several different places, caused by the wire being in contact with it; and finding it impossible to quench the fire, or to touch the wires to remedy the evil we were forced to sever the lines from both ends of the building, or sacrifice it.

SINCE 1870, the telegraph work in Glasgow Post Office has been nearly doubled. In one week in that year, the number of messages forwarded from Glasgow was 5750, the number received 7379, and the number transmitted 7157, making the total number of messages passing through the office 20,286. In the week ending 2nd February this year, the messages forwarded numbered 12,107; received 12,541; transmitted 15,874; total 40,522.—*Iron*.

TELEGRAPH offices have been opened at Hamble (Southampton); Sidcup (Chislehurst), Warriston (Edinburgh).

FIFTEEN insulated wires, enclosed in an iron pipe, boxed in to protect it from injury, have just been laid across the New Tay Bridge.

WE learn from the American medical journals that Electrolysis has recently been successfully applied to the reduction of tumours in the ovary.

HODGSON'S RAILWAY SIGNALS.—At the ordinary meeting of the "Society of Engineers" on the 4th ult., Mr. R. P. Spice, president for the year, delivered his inaugural address. After alluding to Cleopatra's Needle, the telephone, and the electric light, he said:—"I cannot pass by without notice an invention which is of great importance in the working of our railways, and which was brought under public notice towards the close of last year. This is the union of the block and interlocking systems, which has been ingeniously effected by Mr. Hodgson, the manager of Messrs. Saxby and Farmer's Railway Signal Works at Kilburn. The two systems mentioned, if properly worked, afford, on the one hand, a perfect command over points and signals by the interlocking arrangement, and on the other, by the block system, perfect immunity from accidents by collisions, the trains being kept a definite distance apart. But the two systems are worked in-

dependently, and are mutually dependent on each other. There is room for human fallibility to step in and create disaster, and it has more than once done so. By the union of the two systems, however, it would seem to be impossible for accidents to occur, save from the wilful disregard of signals by the drivers of trains. Mr. Hodgson's is a clever mechanical combination of the interlocking and block systems, in which both systems are operating at the same time, and are made to work co-incidently. The invention thus carries the security of the interlocking system a step further, the levers of the points and signals and the handles of the telegraph instruments being interlocked reciprocally, with the result that there cannot be any contradictory working between the out-door signals and points, nor between them and the train telegraph signals transmitted electrically. The system has been approved of by the Board of Trade, and has already been adopted on the London and Brighton Railway."

Patents.

570. "Gyrometers for marine engines and other motors (electro magnets and clockwork)." — W. MORGAN BROWN (communicated by Schaffer and Budenberg). Complete.

596. "Improvements in applying electricity, and apparatus connected therewith." — G. B. BRIGHT, Feb. 13.

609. "Circuit closers for torpedoes." — M. H. ATKINSON, Feb. 13.

610. "An improved electric apparatus for mastering horses."—A. ENGSTRÖM, Feb. 13.

611. "Electro telephonic apparatus."—A. G. BELL, Feb. 14.

617. "Telephones, or instruments for transmitting and receiving articulated and other sounds by electric telegraph."—H. J. HADDAN (communicated by G. B. Richmond), Feb. 14.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

833. "Improvements in electric telegraph apparatus, and in insulated electric telegraph conductors, and pipes or troughs connected therewith." — W. T. HENLEY, dated March 1, 1877. 6d. This consists in improvements in Henley's Alphabetical Instrument (described in Patents, No. 734 of 1861, and No. 2464 of 1861) whereby the operator is prevented from indicating the wrong letter. It provides for improvements in electric bell alarms, whereby a current is sent through an electro-magnet or needle coil, which detaches a detent and allows a lever with weight at the end which has previously been kept at a nearly upright position to fall against another lever which may discharge a train of clockwork arranged to strike any number of strokes on a bell, or ring a bell of any size. The patent also describes an inexpensive and efficient and durable insulating material, formed of a compound of gutta-percha and cotton seed pitch, preferably equal proportions. India-rubber may be mixed with these ingredients, but india-rubber and cotton seed pitch have been previously employed together. The compound in question can be made by heating, masticating, and rolling the materials together, and applied to the wire in a plastic state. Improvements in a protecting trough for insulated wires laid underground are also included.

851. "Improvements in electric telegraph apparatus particularly applicable to submarine cables of great length."—FERDINANDO TOMMASI, dated March 2, 1877. 10d. This apparatus is fully described in the TELEGRAPHIC JOURNAL for Feb. 1st and 15th.

855. "Improvements in protecting submarine and subterranean telegraph cables and wires from the destructive effects of toredo white ants and other marine and terrestrial animalcule and insects."—COL. T. G. GLOVER, R.E., dated March 3, 1877. 2d. This consists in winding a strip of lead foil spirally round the core of the cable, so that its edges overlap a quarter of an inch; and in covering the lead foil with a serving of hemp saturated with castor oil. The outer hemp serving of the cable to be also steeped in castor oil. *(Not proceeded with).*

902. "Improvements in thermo-electric batteries."—CECIL and LEONARD WRAY, dated March 6, 1877. 6d. This consists in improvements on Wray's Thermo-pile (Patent No. 976, of 1867). To prevent the thermo-electric bars from cracking (as bars of bismuth and zinc alloy almost invariably do) an alloy of antimony, zinc, and iron, is used in the proportion of from one to five per cent. of finely divided iron, preferably cast, according to the special purpose of the pile. The iron increases the strength, hardness, and infusibility of the bars. To further prevent the bars from cracking, non-metallic moulds of earthenware, clay, &c., are built up of pieces embedded in sand and loam. The third part of this invention consists in enclosing the bars, when built up into a pile, in clay or other suitable substance in order to protect them from external injury and to enable them to heat and cool down gradually.

1023. "Improvements in apparatus for electro-plating wire."—W. WALLACE, Ansonia, Con., U.S, dated Mar. 14, 1877. 6d. This consists in placing within the bath a slowly revolving shaft carrying the coil of wire to be plated so disposed that all the parts of the wire will be equally exposed to the action of the bath. Thus a uniform and perfect coating of the wire is obtained.

1116. "Improvements in electric batteries, together with the mode of and apparatus for separating iron and other metals from their ores, and in generating electricity and thermo-electricity by or during the electro-deposition of such ores."—W. B. BRAIN, dated March 21, 1877. 4d. This consists in forming a cell composed of an outer vessel of iron, and two inner porous chambers of flannel, &c., one within the other. The space between the two chambers is filled with hematite iron ore; the inner chamber is filled with carbon. Electrodes are fixed to the carbon, ore, and iron vessel. The carbon is steeped in a mixture of nitric, sulphuric, and chromic acids. The ore is steeped in hydrochloric acid and chloride of ammonia. The ore, it is stated, will be found electro-positive to the iron and electro-negative to the carbon, or, in other words, a current will pass from it to the iron, or to it from the carbon. Chloride of iron is formed. The action is considerably increased by heating. To deposit pure iron the outer vessel is made of zinc, or zinc is put in the place of the carbon if the iron vessel is retained, and chloride of iron solution is put in place of hydrochloric acid and chloride of ammonia.

1273. "Improved apparatus for generating and applying electricity for medical purposes."—G. EDARD, Paris, dated March 31, 1877. 8d. As set forth, this invention consists "in providing a source of permanent static

electricity, one element of this dry pile being formed by an electro-magnet of suitable form and dimensions embedded in magnetic iron ore in the form of dust or sand. Several elements are combined together to form electric friction brushes, belts, corsets, abdominal supports, garters, hose, bonnets, and other bodily appliances."

Correspondence.

THE CONTACT THEORY OF VOLTAIC ACTION.

To the Editor of THE TELEGRAPHIC JOURNAL.

Sir,—When contributing his paper, "On the Difference of Potential produced by the Contact of Different Substances," to the Royal Society, on May 22nd, 1877, Professor Clifton, of Oxford, seemed to be quite unaware of the elaborate series of experiments on exactly the same subject made by us in the winter of 1875, a full account of which was communicated in a paper on "The Contact Theory of Voltaic Action, paper No. 1," to Prof. Sir W. Thomson, May 6th, 1876, who at the British Association meeting at Glasgow of that year gave a public account of the method employed by us and the results we obtained, reserving our complete paper for the pages of the proceedings of the Royal Society.

If the investigation in question had been of merely ordinary importance we should not have deemed it necessary to point out the priority of our experiments to those of Professor Clifton; but when the fact is remembered, a fact not very evident from Professor Clifton's paper, that a series of experiments such as we performed, clears up the long standing discrepancies between the chemical and contact explanations of voltaic phenomena, and so is of extremely great importance in the science of energy, we trust we may be pardoned for claiming the priority due to us. Much of the ordinary original work performed in physical laboratories must, of course, be undertaken nearly simultaneously in different countries, and our great distance from Europe necessarily places us in the unfortunate position of being some months in time behind other men who publish papers in the same societies as ourselves; but in this particular case the work was not of an ordinary kind, and we have not to ask for the indulgence of scientific men in making allowance for our residence in Japan, seeing first, that our paper reached England exactly one year before Professor Clifton's communication was made to the Royal Society, and secondly, that Sir W. Thomson was so kind as to give an account of our method and results to the British Association several months before Professor Clifton appears to have commenced his earliest experiments on the subject.

The method of experimenting employed by this gentlemen is essentially the same as that used by ourselves with this important difference, that whereas Professor Clifton only removes the plates of a condenser from a distance *a* apart to a distance *b* apart, we removed them to an infinite distance apart, and then put them in such a position that the original charge to be measured was doubled; so that, in fact, our method was by far the more delicate, and was only limited in sensibility by the natural imperfections of mechanism. All this was clearly shown in the carefully executed drawing that accompanied our paper. The advantages we derived from the superior delicacy of our apparatus are seen if we examine, as may be easily done, the two papers, paragraph by paragraph, for—the metals and liquids employed by Professor Clifton being the same as those used by ourselves—in every case that he, in 1877, was only able to detect the sign of the difference of potentials, we, in 1876, published not only the sign but also the numerical value of the difference in question (compare pages 301 to 305 of his paper, in the Proceedings of the Royal Society, No. 182, with our paper). Considering too, that the quantities of electricity to be measured are so small, and consequently the slightest loss of electricity is so serious, we fail to see what benefit was derived from using six insulating stems instead of only two carefully protected insulating rods of our apparatus.

We observed that Professor Clifton assumes throughout his paper "The Summation Law of Electromotive force," and that he was compelled to make such assumptions in consequence of his inability to measure *directly* with his apparatus the difference of potentials between two *liquids* in contact. But if this law be assumed, then we might have employed in our research the method of measuring the difference of potentials of two liquids in contact that we had often, as early as 1874, employed as a lecture illustration to indicate this difference.

This method consisted in attaching to the terminals of a quadrant electrometer, two platinum wires, of which the ends were respectively dipping into two liquids separated by a porous diaphragm; but to make use of the observations obtained from such an experiment, it must be assumed that the observed deflection of the electrometer represents the algebraic sum of the three contact differences of potentials, such as might be measured separately. At first sight, not to assume this, might appear to be a refinement of caution on our part, but in reality it was imperative to prove experimentally that this assumption was true, when it was taken in connection with the statements generally made by the supporters of Thomson's theory of contact. For example, Professor Fleeming Jenkin says, on page 44 of his "Electricity and Magnetism":—"When a single metal is placed in contact with an electrolyte, a definite difference of potentials is produced between the liquid and the metal. If zinc is plunged in water the zinc becomes negative, the water positive. Copper plunged in water also becomes negative, but much less so than zinc. If two metals be plunged in water (as copper and zinc) the copper, the zinc, and the water forming a galvanic cell, all remain at one potential and no charge is observed on any part of the system." Consequently in 1875, we discarded our original proposed method of experimenting which was to use an apparatus somewhat similar to that employed by Professor Clifton, as far as we can understand it without a drawing, and we constructed the apparatus described in our paper, which enabled us to measure any single contact difference of potential whether of a metal with a metal, or a metal with a liquid, or a liquid with a liquid, or a combination of any two or more contacts.

The very important fact that the rise of the difference of potentials between the plates of a voltaic cell, on first immersion when the circuit remains open, is due to the same cause as polarisation of the plates when the circuit is closed, but operating in the opposite direction as explained by Professor Clifton, was clearly stated by us in our paper in question under the head of "The Three States of a Cell," and our subsequent papers showed that we considered this effect to be analogous with the so called soaking in and soaking out in any dielectric, or what is called the residual charge in a Leyden-jar, a subject to which we have been since devoting much attention; but we even went further, for we found that even when the circuit was closed

directly after immersion, there was first a rise of difference of potentials followed afterwards by a fall, and this in an explanation of the want of constancy observed in many cells, and notably in the two-fluid cell described by Professor Clifton, page 309.

We take the liberty of observing that, although a table of the difference of potentials of the terminals of different cells is of great value to practical men, still we should hardly have expected to find such a table at the end of Professor Clifton's paper, with only one number (almost without exception) given for each cell, since he was quite aware that the difference of potentials between the electrodes alters from the first instant of immersion of the plates. Again, we do not understand how he can say that no current has passed, for it is evident that a current may pass without the electrodes being externally connected. A table such as is given by Professor Clifton would be very valuable if it gave the difference of potentials between the electrodes when the plates had been immersed for a sufficient length of time for the difference of potentials to reach its maximum value, but it would be more valuable if it gave the time rise of the difference. We confess, however, that it is only with exceptional cells that we have succeeded in getting on different occasions exactly the same results with the same combination. Such a table as we suggest, which would be a great improvement on that given by Professor Clifton, could of course be constructed by any one possessing an electrometer without any special apparatus.

In conclusion, we notice, page 299, that Professor Clifton sees the necessity of changing his apparatus, which could not measure directly the difference of potential between two liquids, before he can obtain satisfactory measures of the difference of potential in certain important cases. We may mention that, although we measured with considerable accuracy the difference of potential of several pairs of liquids with our apparatus, as described in our paper of 1876, still we thought it advisable, in the summer of that year, to construct a new apparatus, the accurate results obtainable with which will form the subject of our next paper on this subject.

We beg to remain, Sir,
Very truly yours,
W. E. AYRTON.
JOHN PERRY.

The Imperial College of Engineering,
Tokio, Japan.
December 14th, 1877.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

AT an Ordinary General Meeting, held on Wednesday, the 13th inst., at the Institute of Civil Engineers, Professor ABEL, C.B., F.R.S., Past President, in the chair, a very interesting paper was read by Mr. W. H. Preece, Vice-President, on "American Telegraphy."

It will be remembered that, during the spring of last year, Mr. Preece and Mr. H. C. Fischer, of the Postal Telegraph Service, were commissioned by the Government to proceed to America for the purpose of reporting upon the various systems in operation there.

Leaving Liverpool, per *Abyssinia*, on the 4th of April, 1877, Messrs. Preece and Fischer arrived in New York on the 14th of that month. Here they were well received; and Mr. Preece speaks loudly in praise of the frank manner in which the various telegraph authorities threw everything open to their inspection.

After "doing" New York, our Commissioners proceeded to Philadelphia, Baltimore, and Washington; thence crossing the Alleghany Hills to the valley of the Ohio and to Cincinnati, they proceeded to Indianapolis and Chicago. From Chicago they entered Canada (visiting Niagara, *en route*, of course), and passed successively through Montreal, Quebec, Portland, and Boston to New York. The whole tour in America occupied about three weeks.

Mr. Preece, before passing to the real business of his paper, gave a short and humorous description of his experiences in travelling, specially mentioning hotels, railway-cars, and river steamers. *Apropos* of railways, it was observed that there is an almost entire absence of railway signals in America.

The constitution of American telegraph companies is somewhat different to our own. The president of the company is not only chairman of the board of directors but also general manager—in fact, both administrative and directive head. The vice-president also takes distinct administrative duties; they are joint executive officers.

The telegraph system of America is a very large one. Exact statistics are difficult, if not impossible, to obtain, partly because an enormous number of companies have been started at various times, some of whom do not publish their accounts, and partly because different States keep their accounts in different ways.

In the United States and Canada there are, altogether, some 300,000 miles of wire. The Western Union Company have about 195,000; the Atlantic and Pacific Company, 36,000; The Montreal Company, 20,000; the Dominion Company, 7,000; smaller companies and railways, 40,000. There are some 11,660 stations; and, during the last year, 28½ millions of messages were carried.

Embarked in this enormous enterprise is a sum of 60 million dollars (£12,000,000) of capital; the amount of capital lost it would be difficult to estimate. Some idea of the number of ventures which have been started from time to time and absorbed may be gathered from the fact that the Western Union Company alone comprises over 200 smaller ones.

Local companies are numerous, such as the Gold Stock Company of New York (similar to our Exchange Company), the Law Telegraph Company, which enables lawyers to hold consultations with each other and with their clients without leaving their offices, district companies, &c. Then there are the railway companies' telegraphs, and about 2,500 miles of military telegraphs, which render good service in reporting meteorological changes, and in foretelling storms.

The tariff in the United States is very anomalous. A ten word basis is adopted, and free address of receiver is allowed, the sender's signature only being telegraphed. Beyond ten words, messages are charged at per word. There is a "local tariff" for short distances:—25 c. for 25 miles or under, 50 c. for more than 25 but not over 50 miles. Then there is the "square" rate, which is as follows: The whole country is divided into squares of 2,500 square miles each. Then the tariff from any place in one square to any place in another square is computed upon the air-distance between the centres of the respective squares. For distances beyond 1,000 miles, however, another rate comes in, called the "state" rate, based upon the distance between the respective states. In addition to these there are "special" rates, "half-rates," and a number of others, the whole being very puzzling to a foreigner.

In England, pre-payment of messages is compulsory; but in America they have "collect" messages, the payment for which is collected on delivery. This is one of

the bad results of great competition. There is another feature wherein their practice differs from ours, viz., "deferred" messages, which are messages handed in one evening for delivery next morning. This is a valuable privilege to the public in places a long way apart, and separated by two or three days' post. The result is that between New Orleans and New York 42 per cent. of the traffic is done in "deferred" messages, while at Baltimore the proportion is only six per cent. Of the total Western Union traffic, 13 per cent. is "deferred."

Comparison between the two countries is difficult; but, practically, telegraphy is cheaper in England than in the States, the ratio being as 1s. to 1s. 10½d. On the other hand, the average distance in America is seven or eight times the English. Press arrangements are not superior to ours. News is collected by a Press Association, and carried by telegraph companies at low rates, viz., 1 c. to 10 c. per word, the lowest being 1 c. per word for 500 miles. Additional copies are supplied to newspapers at half-rates. The average rate for a message from the Press Association to a newspaper in any part of the States is 4s. for 100 words, extra copy 2s. In England these are 1s. and 2s. respectively; and consequently we do more press work than they do in America. In England, on an average, 700,000 words are transmitted nightly, and two millions of words are delivered to newspapers every morning, being about ten times as much as in the United States.

American companies are obliged to carry Government messages at 1c. per word per 500 miles; and a large business is done in this direction, as also in free messages which form a large per-centage of American traffic.

The telegraph service is quite a favourite one in America, and it is quite the exception there to meet a person who knows nothing about telegraphy. At Harvard, the undergraduates have their services of telegraphs, and form themselves into companies, it being quite an honour to belong to the leading companies. Telegraphy being used to a large extent on railways, the railway servants are mostly accustomed to it, and there are few station-masters who have not at some time or other been operators.

There is a large demand for operators in the various companies, and consequently a plentiful supply. The pay is good, the average salary of an operator in the Western Union Co. being £192, while in England it is only £80. Great pride is taken in the work and many of the operators become very skilful. Mr. Preece does not consider the scientific attainments of the staff equal to that of the English staff, a fact which he attributes to the absence of submarine cables.

Females are employed by the American companies, though not to so large an extent as in England.

The alphabet in use in the States differs slightly from ours, some of the letters being "space" letters, *i.e.*, letters in which the dots or dashes are separated by a space equal to a dash. This system is probably slightly quicker than ours, but Mr. Preece considers it leads to more errors.

With regard to engineering details, the American lines are chiefly characterised by extreme simplicity and uniformity in the stores used and in the manner of performing the work. In the early days of telegraphs the railways were seized by the first companies, later comers being driven to the roads; both are now plentifully covered with lines. The average cost of a one wire line is from 100 to 150 dollars per mile, not much more than with us. Very little underground work is used, but on the other hand street work is far too commonly resorted to. Mr. Preece was strong in his denunciation of the unsightly lines of wires which, even more than here, disfigure the best streets of large towns. No thoroughfare, however beautiful, is free from invasion by telegraph companies; in some places two or three rival lines exist side by side in the same street. For some of these town lines poles of enormous height are used. In New York and Philadelphia there are poles 90 to 96 feet high, and in Chicago 75 feet. These gigantic poles are, of course, erected at great cost.

(*To be continued.*)

THE INSTITUTION OF CIVIL ENGINEERS.

AT the Meeting on Tuesday the 12th of February, Mr. BATEMAN, President, in the Chair, the Paper read was on "The Evaporative Power of Locomotive Boilers," by Mr. J. A. Longridge, M. Inst. C.E.

In this communication the author endeavoured to set at rest certain widely diverging opinions which existed among practical men, with reference to the evaporative efficiency of the various elements of a locomotive boiler; such as, the area of the fire-grate compared with the total heating surface, the ratio between the tube surface and the fire-box surface, and the rate of combustion per square foot of fire-grate. The cause of such divergence of opinion was due to the multitude of variable conditions; and it was only by embodying these in a symbolic formula that the relative effects could be estimated.

After adverting to Mr. D. K. Clark's formula, $w = a r^3 + b c$, and pointing out that, from its empirical nature, it was only applicable within certain limits, the author investigated a new formula, based upon well known physical laws and mathematical principles. Assuming any given consumption of fuel per hour, the amount of heat generated was first determined; then, from the laws of the transmission of heat through plates, the quantity which passed through the fire-box surface into the water was deduced, and from what remained, the temperature of the gases entering the tubes was found. From this the loss of the temperature in passing through the tubes was calculated, based upon the same law of transmission, and thus there was obtained the temperature of the gases in the smoke-box. From the loss of temperature in passing through the tubes, the evaporative effect of the tube surface was ascertained, and this, added to that of the fire-box, gave the total evaporative effect of the boiler.

From the author's formula the evaporative powers of twenty engines were calculated, and the results compared with actual experiment and with those given by Mr. D. K. Clark's formula. It was shown that the tube surface was a very important element, and that on an average the tubes effected nearly 80 per cent. of the whole evaporation. Also that the generally-received idea, that 1 foot of fire-box surface was equal to 3 feet of tube surface, was fallacious; indeed the proportion was very variable, for while, in the "Ixion," 1 foot of box surface was only equal to 1·7 foot of tube surface, yet in No. 33, Caledonian Engine, 1 foot of box surface was equal to five feet of tube surface. Consequently no fixed ratio could afford a safe rule for practice. It was then demonstrated that the length of the tubes had nothing to do with economy of evaporation, but that this depended simply upon the ratio between the consumption of fuel per hour and the total absorbing surface. The question of the diameter of the tubes was next discussed, the late Mr. Zerah Colburn's views being dissented from; and it was shown that the diameter was a matter of no consequence so long as the proper amount of surface was obtained. The same remark might be made regarding the ratios between the fire-grate and the heating surface. It was not the area of

the fire-grate, but the weight of fuel consumed per hour, which had to be considered; and as regarded economy of evaporation, it mattered little whether 50 lbs. of coke per square foot per hour were burned in a grate of 20 square feet area, or 100 lbs. per square foot per hour in a grate of 10 square feet area. In each case, if the absorbing surface were the same, the economy of evaporation would be the same.

The question, how far the combustion of fuel was perfect, was then examined; and it was pointed out that in many cases it was very far from being so, some French experiments exhibiting losses of from 22 to 39 per cent.

The general conclusions arrived at might be thus summed up:—that no fixed rule could be established as the best for the relative proportions of the fire-grate, fire-box, and tube surfaces; that length of tube had nothing to do with economic effect; that the diameter of the tube was also a matter of indifference; that economy of fuel did not depend upon the rate of firing; that when the quantity of fuel burnt was moderate, say 50 lbs. or 60 lbs per square foot of grate per hour, the combustion was nearly perfect, while with hard firing there was considerable loss from carbonic oxide passing away unconsumed; and that a large increase of heating surface in proportion to coal burnt only slightly increased the economic effect, which within the limits of practice in locomotive engines was nearly in proportion to the fourth root of the heating surface.

In the discussion which followed, and which was continued on Tuesday, the 19th of February, most of the speakers expressed their sense of the value of the Paper, and their concurrence in many of the views enunciated in it. Mr. Clark said that his formula had been constructed from the results of three hundred experiments. Mr. Bramwell pointed out that in former times, when coke was the fuel employed, the area of the fire-grate was an important element, as affording the only means of access of air; but that, now, as the use of coal necessitated the admission of air in front to ensure combustion, the area of the fire-grate was of little consequence. Fuel might be applied in the solid, liquid, or gaseous state; in the latter state the surface exposed to combustion is infinite; in the liquid state the surface exposed is very great; but in the solid state the surface exposed depends entirely on the size of the pieces of fuel; and Mr. Bramwell affirmed that the efficiency of combustion depends largely on the method of firing, and that it is greatest when small amounts of fuel are being constantly put on; but that as such a method conducted by manual labour, would involve too great expense in wages, mechanical means of firing should be devised. He remarked that for economy in combustion an excess of air was preferable to a deficiency; and he advocated a series of trials of locomotives being made similar to those instituted for agricultural engines by the Royal Agricultural Society, which had been attended with such excellent results. One speaker observed that no such trials were needed, as all locomotives were under constant trial in the usual course of working, and that promotion was granted to the men mainly for economical firing. Another speaker said that the adoption of the amount of fuel consumed, as a standard of comparison, was like estimating a man's value by the wages he received instead of by the amount of work he accomplished, and that the quantity of water evaporated should be taken as the standard. Mr. Longridge, in reply, expressed his opinion that it was thoroughly established by experiment that the combustion was equally efficient, whether the firing was done gradually or in a mass. He considered his formula applicable to all cases, whereas an empirical formula, like Mr. Clark's, failed in certain instances to give correct results; and he claimed for his Paper the merit of practical utility, as affording a ready means of ascertaining the most advantageous dimensions for the various parts of locomotive boilers.

PHYSICAL SOCIETY.—16th FEBRUARY, 1878.

The President, Professor W. G. ADAMS, in the chair.

THE following candidate was elected a member of the Society:—Mr. G. H. West, M.A.

Dr. LODGE read for Mr. H. F. Morley, M.A., a paper on "Grove's Gas Battery." After referring to the views of M. Gaugain and Mr. Grove himself with regard to the cause of the action of this apparatus, the author proceeded to describe an elaborate series of experiments he has recently made in order to ascertain the circumstances by which it is regulated. It would be impossible to give a clear account of them in a short space, but some of his conclusions are as follows:—The whole of the current is due to dissolved gas, and if n be the distance of the level of the liquid from the top of the plate in the H tube, and $E = \frac{C R}{1000}$, C being given in galv. readings and R in ohms, he finds that, approximately, $(1 + n\,a)\,C = b + n\,e - (c + n\,d)\,E$ where a, b, c, d, and e are constants. The electromotive force is not constant, but rises with the resistance. The current is greater in proportion as the gas present in the elements is less; and, finally, the current appears to vary directly with the pressure.

Mr. S. C. TISLEY then described the harmonograph, specially referring to its use for drawing pairs of curves for the stereoscope. This, the latest form of his pendulum apparatus, is capable of giving a very great variety of curves, for, in addition to rectangular vibrations, parallel and elliptic motions can be combined by its means. In the older form of apparatus each pendulum moves on the other as a centre, whereas in the instrument described they are independent. One pendulum carries at its upper end a table which can be caused to rotate by clockwork if required. The whole is supported on a kind of gimbal-joint formed of two pairs of knife-edges at right angles, so arranged that vibration can take place either on one or the other, or the two can be so combined as to give a circular motion; or, again, the pendulum can be caused to vibrate in any given plane. The second pendulum vibrates in the plane in which the two hang, and carries at its upper end an arm terminating in a pencil over the table of the other pendulum. A very ingenious adjustment renders it possible to raise or lower the bob of the second-named pendulum during its motion. If two pens be attached, about 2½ inches apart, instead of the single one usually employed, and two curves be traced, they are not precisely similar, and when viewed in a stereoscope they are found to give the well-known appearance of solidity to the figure. It was further shown that by gradually changing the relative motions of the pendulums it is possible to impart to the curve many of the forms observed in biaxial crystals in the polariscope.

Mr. F. G. M. PAGE then exhibited the action of the telephone on a capillary electrometer. The construction of Lippman's Electrometer, as modified by Marey, was first explained, and the meniscus of the mercury in the capillary tube was thrown on the screen by the electric light. The delicacy of the instrument was shown by passing a current of $\frac{1}{1000}$ of a Daniell, which caused a distinct movement of the mercury. Resistance of 5000 ohms and $\frac{1}{10}$ ohm gave approximately the same deflection: so that, in practice, the instrument

may be considered to be independent of resistance; in addition to which it possesses the great advantage of portability, and its indications are almost instantaneous. To illustrate the use of the electrometer for physiological investigations, a frog's heart was connected by non-polarisable electrodes with the instrument; each beat of the heart caused a considerable movement of the mercury column. A telephone was now connected; on pressing in the iron plate the mercury moved, and on reversing the wires the movement was seen to be in the opposite direction. On singing to the telephone each note produced a movement, but the fundamental note of the plate, as well as its octaves and fifths, had the greatest effect. On speaking the mercury oscillated continually; some letters of the alphabet had scarcely any effect, and the *w* was especially curious, producing a double movement. Reversing the wires did not alter the character or *direction* of these movements. The same effect was observed when the telephone was in the primary and the electrometer in the secondary coil of a Du Bois Reymond's induction coil. In conclusion Mr. Page showed the contractions produced in a frog's leg; on inserting under the sciatic nerve two platinium wires coupled with the binding screws of a telephone, and talking to this instrument, violent contractions ensued.

In the course of the discussion which followed, Prof. GRAHAM BELL expressed himself as highly gratified at the results of Mr. Page's experiments. He has made very many attempts to ascertain the strength of the current produced by the human voice in vain, but considers the present method will, in all probability, give some most valuable results. He was quite unable to account for the fact that the motion of the mercury took place *from* the opening, but this seems to depend on conditions not yet determined.

Mr. WILSON then exhibited for Prof. S. P. Thompson a Lantern Slide Galvanometer for showing the deflections of the needle to an audience. It consists of a coil of insulated copper wire wound on a flat bobbin, within which a needle is balanced on a horizontal axis; this needle carries a long needle of aluminium traversing a semicircular divided photographic scale, and as this is transparent, the index can be projected on to the screen. The whole is enclosed between two glass plates.

General Science Columns.

MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS, SESSION 1876-77. PART III.

THREE of the papers read and discussed at the meetings of the Institution during last session appear in this volume. The volume, moreover, besides some selected papers not read at the meetings, and the usual complement of abstracts, contains several additional contributions to the discussion of the paper on the Sewage Question, published in the preceding volume, and also some memoirs of deceased members.

In the first paper, on the "Transmission of Power to Distances," Mr. Robinson treats of the various methods, such as water pressure, steam, compressed air, shafting and ropes, by which power produced at one place can be transmitted to another.

Water pressure stored up in accumulators, and distributed in pipes to hydraulic engines is extensively used in docks where the demand for power is intermittent. For instance, lock gates, capstans, and swing bridges over entrance locks only require to be united near high water, and a steam engine by working continuously and storing up the power in an accumulator (in which the water is pumped up to a height in a cast-iron cylinder, and pressed upon by a weighted ram working in the cylinder), is able to exert in a limited period a power which it would be quite unable to produce within the required time. The power, moreover, thus applied is steady, readily controlled, and capable of transmission to long distances. The loss of efficiency varies between 10 and 50 per cent., according to the machine to which it is applied. The defect of the system is, that when an hydraulic machine has occasion to exert a force considerably below its full working power, the loss of power is the same as if it had exerted its full force. Thus, if an hydraulic crane raises one ton or ten tons, the water expended is the same. The mean cost of water power is 1·26d. per foot-ton, as gathered from numerous instances.

Steam may be economically applied for transmitting power to short distances; but for long distances, owing to the variations in temperature, there is a difficulty in maintaining tight joints, the pressure is liable to fluctuations, and condensation causes loss of power.

Compressed air is frequently employed for transmission of power: it is very suitable for underground operations where in many cases steam or water would be objectionable. It has the advantage of accommodating the power to the work to be done, but the disadvantage of considerable loss of effect, amounting to at least 50 per cent. Its loss also by friction in transmission is much greater than in the case of water, owing to the far larger volume of air required to transmit the same pressure. Exhaustion of air has been tried for the same purpose, and has been utilised by the Post Office for the transmission of messages in pipes.

Shafting and ropes are only applicable for comparatively short distances.

Another method of transmission of power by the electric current, not mentioned in the paper, appears likely to go far beyond all other hitherto known methods, both as regards the distance of ready transmission, and the small loss in efficiency when the power transmitted is made to increase directly as the distance.

The second paper is on "The River Thames." Only a portion of the river, viz., between Teddington and its mouth, is dealt with by Mr. Redman. The paper furnishes a historical survey of the different changes which have occurred in this part of the river; and special reference is made to the tidal variations due to the removal of the old Westminster, Blackfriars, and London Bridges, the construction of the embankments, and the dredging operations of the Conservators. It appears that the removal of obstructions has raised the high water level, and doubtless the

embankments by reducing the reservoir area, have, to some extent, aided this result. The channel of the river has been greatly improved, and Waterloo Bridge is the only important obstruction still in existence, and in the last half century the volume of tidal water flowing in above London Bridge has increased thirty-three per cent. The extension of the embankments on the southern side of the river, is the chief improvement required; and when we consider that any works for diminishing floods in the upper portions of the river will bring down the flood waters more rapidly and in larger volumes than at present, it is evident that works for securing the low lying portions of the metropolis on the Surrey side of the river should be undertaken without delay.

The third paper is by Professor Hull "On a deep Boring for Coal at Searle, Lincolnshire." This boring, though carried down to a depth of 2,030 feet, whilst bringing to light several interesting geological facts, has not hitherto been taken low enough to decide the main question for which it was undertaken, namely, what is the easterly limit of the Yorkshire coal measures beneath the newer formations.

PROSPECTS OF THE ENGINEERING PROFESSION.

THE stagnation of all enterprise, which has now for some time been severely felt by members of the engineering profession, both civil and mechanical, cannot, in the ordinary course of events, be expected to last indefinitely. The present position of affairs has not wholly been brought about by the unsettled state of Europe generally, but may, in some measure at least, be attributed to over production and over construction during the period of the last season of prosperity. The benefits of this are now being realised by the public generally; but as soon as the means of supply had exceeded the normal rate of demand, prices fell and producers have had hard times ever since. Each season of great prosperity in any branch of industry is sure to be followed by a rush of persons to share in the gains: thus, when civil engineering is in its zenith, and the leading members of the profession have their hands full of work, the juniors all find occupation, and the numbers of engineering pupils increase, as a rule, far beyond the probable future requirements of the country; and these, when times are dull, have for the most part to fall back upon their friends, or turn their hands to some other occupation, some only temporarily, but many for good; a sufficient body, however, always remain to keep up the numbers of the profession at a strength equal to any probable future requirements for their services. The engineering works of this country during the past forty years have extended at a rapid rate, and it does not now seem possible for any great and continuous length of railway to be projected to meet any possible requirements that are not already served by existing lines, and the only probable extensions must, therefore, for the most part, consist of short and unambitious sections. But although the future field of railway engineering, so far as construction is concerned, is limited in this country, and native engineers are employed in the construction of lines in foreign countries where English engineers formerly were engaged, there still remains a vast field of undeveloped wealth in India and our numerous colonies, owing to the want both of population or of communication, and in some instances of both. When a railway is constructed, however, the work of the engineer cannot fairly be considered at an end in connection with it. The demands of increasing traffic have led to the introduction of the block system, and of continuous breaks, by the aid of which the carrying powers of a line are considerably increased; and there appears no reason why, by the introduction of further improvements, which it rests with the engineer to design and subsequently carry out, their capacities should not be still further extended beyond anything that has hitherto been effected. In shipbuilding, engineers have scarcely yet built anything in excess of the dimensions of the first floating vessel of which any records exist, and doubtless there yet remains ample scope for improvements in the design and construction of ships, and in the various machines connected with the working of them. The introduction of steel for purposes of construction will afford vessels a larger carrying power in proportion to their dimensions, and so give them the means of yielding greater commercial profits to their owners. By the improvements in boilers, in recent years, the consumption of coal on board of steamers has been greatly diminished; but it can scarcely be doubted that in course of time coal will be superseded for this purpose, and perhaps a more subtle power than steam, will take the place of the present cumbrous machinery now employed for propulsion. This is a question which deserves the attention of engineers, and for which a wide field presents itself. There seems also no reason why some sort of brake power should not be applied to vessels on the seas as a means of protection against collisions, or to enable them to bring to suddenly when required, as well as to railway trains. Whilst for commercial vessels the engineer is required to promote in every way economy and safety, for fighting-ships he has to develope fresh means of destruction and protection; vast as are the powers now employed for these purposes, it cannot be doubted—judging from the advancements in these made in recent years—that far greater powers in both directions are capable of being developed than at present exist. With the extension of commerce, and the increase in the numbers of vessels, harbours and dock accommodation must ever be required on an extended scale where they now exist, and for the convenience of new ports, as these spring into existence in parts of the world hitherto too sparsely populated to justify their indulgence in such commercial luxuries, but which in time must become necessities.

The means existing for raising sunken ships are, it must be admitted, miserably defective, and yet a vast and profitable field of labour lies open to any one who may succeed in recovering from permanent loss vessels once sunk to the bottom of the ocean. The conveyance of fresh meat from the prairie fields where cattle are only valued for their hides and hoofs, to the teeming populations of densely-packed European towns and villages, is still a question open for practical solution, dependent in a great measure upon the engineer for its accomplishment.

In mining and quarrying the scope for practical application of more economical and effective means of work is practically unlimited, and in our colonies and India untold wealth yet remains undisturbed where it has laid hidden since the development of the orbs from chaos. In India particularly, where there is already an extensive population, more than half of whom are dependent on agriculture for a living, the development of new industries and manufactures is all important, and by nothing else will this be more readily accomplished than by developing the mineral resources of the country. India is indeed a country which in the midst of wealth is poor, and nothing but British energy, guided by engineering skill, can recover it from its present position. The mechanical arts and manufactures are ever open to improvement at the hand of the engineer, and the keen competition of the present day must give the pre-eminence to those who are ever seeking for improvements and economies in the production of their manufactures, from a pin to a steam engine, by the introduction of improved appliances. Where legislative enactments are powerless to protect the country from the serious loss caused by trade strikes, the engineer is looked to for the provision of mechanical contrivances to supersede skilled labour, and many of our most remarkable labour-saving machines owe their introduction to this cause. No one will for one moment deny that ample room still remains for further inventions in this direction. The earth and the water are now the highways of the world, but science has not yet succeeded in tracking the regions of the air in a manner suitable for providing a regular system of aerial locomotion. This has been the fancy of poets and day-dream of philosophers, and it still waits upon our engineers for successful accomplishment.

At almost all times it has been the cry that nothing more remained for engineers to accomplish; like the cry of the warrior of old, there remained no more worlds for them to conquer. Yet, notwithstanding the lament, the numbers of the profession have ever been steadily on the increase, ready to meet the constant demand for their labours, in consequence of extensions in old channels, or the developement of new branches of engineering following upon the increasing requirements of man. The very birth of the engineering profession scarcely extends beyond the length of a single life, whilst within quite recent years there have been added to it the several branches connected more especially with telegraphy, sanitation, gas and water supply. As time advances, Nature appears to be opening to man's view with ever increasing rapidity her storehouse of knowledge, and although the times are, at present, doubtless wanting in that material advancement which so conspiciously distinguished the immediately preceding years, we may rest assured that it is but a pause on the general onward progress of science and labour, and judging from the past—which is usually no incorrect reflection of the future—there can be little doubt that the time is not far off when the energies of the profession will again be heavily taxed, and new enterprises and new industries will demand from the man of science, and the practical engineer, those services which have been so successfully rendered in the past.

THE RADIOMETER AND THE SPHEROIDAL STATE.—The following lucid exposition of the latest theories explaining the action of Crooke's radiometer, and the cause of the phenomenon known as the spheroidal state, was given by Professor Barrett in a recent lecture at the London Institution. He said, "To Mr. Stoney is unquestionably due the great honour of having been the first fully to explain the true theory of the radiometer." It was in the course of these investigations that Mr. Stoney has been quite recently led to show that the force which is so active in the high rarification (that is necessary for the effective rotation of the radiometer) is also present at ordinary atmospheric tensions. Now it is this force which forms the new explanation of the spheroidal state. In order to understand the action that occurs, it must be recollected that, according to calculation, the number of molecules of air that at ordinary pressure occupies the space of a pin's head is 1,000,000,000,000,000,000; when the radiometer globe is exhausted of these molecules of air, as far as we can do it by mechanical means, there are still some few millions remaining, and these are in constant motion. Heat makes them move more rapidly, cold more slowly. If we have two surfaces placed very near each other, one surface hot and the other cold, from the hot surface the molecules will be thrown off with greater rapidity than they reached it; and if the cold surface be near enough they will "bombard" it. Hence there will be a tendency in the hot and cold surfaces to retreat from one another, and when with one of these, as in the radiometer this is possible, it ensues. This force would obviously disappear (1) if the residual molecules could be wholly removed or so lessened in number that their action would be insensible, or (2) if the surfaces were so far apart that the augmented molecular activity had expended itself before reaching the cool surface. Applying the same kind of reasoning to the spheroidal state of liquids, we can see that it is only at relatively short distances from the metal that the interaction will occur. Professor Barrett showed by experiment that the spheroidal state could be produced with fluids from

which there could be no vapour given off, as the old theory required; and also that it could be produced in cases of very slight differences of temperature.

ELASTICITY OF PALLADIUM WIRES.—M. Gesechus finds that the co-efficient of elasticity of palladium, and of its alloys with silver and gold, diminishes during absorption of hydrogen by the wires. When the hydrogen is evolved from the wires the co-efficient returns to its original value. The strongest effect was obtained with a wire composed of 75 per cent. of palladium and 25 per cent. of silver.

OSMIUM AND IRIDIUM are the hardest metals known which can be found in any appreciable quantity. They are therefore likely to become useful for rock-drills, graving tools, philosophical instruments, balances, watches, &c. They are highly immalleable, and require the oxy-hydrogen flame to melt them. They are at present chiefly obtained from the mines of the Pacific slope, N. America.

MALLEABILITY OF GOLD.—According to the *Journal of the Franklin Institute*, Mr. Outeridge, the Master of the Mint, Philadelphia, has made the following experiments, which show how infinitessimally thin is the coating of gold necessary to gild a metallic surface. A plate of copper $\frac{1}{3000}$ of an inch thick was taken, and a strip 8 inches long by $2\frac{1}{2}$ wide, giving a surface of 20 square inches, was cut from it, polished, and then weighed by a fine chemical balance. A coating of gold sufficient to produce a fine gilding was then deposited on the strip by means of an electrotype apparatus, and the strip weighed anew. The increase of weight was found to be $\frac{1}{10}$ of a grain, thus showing that a grain of gold is capable of electro-plating 200 square inches of surface. With the same quantity of beaten gold only 75 square inches could be covered. The thickness of the electro-plating was estimated at $\frac{1}{680400}$ of an inch, whereas the thickness of the beaten gold in question would be $\frac{1}{367850}$ of an inch. Seen under the microscope the thin gold skin was seen to be perfectly continuous and of a uniform pure golden tint. Detached from the copper by means of nitric acid, which dissolves the latter and leaves the gold unattacked, the skin appeared semi-transparent, and when held between the eye and the daylight it took the fine green colour of gold. Mr. Outeridge has succeeded in producing films of gold $\frac{1}{270000}$ of an inch thick, that is 10,584 times thinner than ordinary writing paper. A film of this thickness obtained from a grain of gold would be sufficient to plate four square feet of copper plate.

MOLECULAR CONSTITUTION OF ICE.—In order to determine what are the conditions which determine the formation of non-transparent and transparent ice, M. R. Pictet freezed some water in a vase by immersing it in a chilled solution of glycerine. When the temperature of the water was kept between 0° C. and — 1·5° C., the resulting ice was quite transparent; but if the temperature was kept below — 3° C., the ice was whitish and of less specific gravity, according as the degree of cold was intensified. The opacity of the ice was found to be due from an irregular arrangement of its crystals as well as to the presence of little globules of air of less than a millimetre diameter, which were mechanically enclosed in it. These small globules could be cleared away by carefully collecting them with a larger bubble.

COMPRESSED GLASS.—Messrs. Siemens of Berlin, manufacture a kind of glass compressed by means of laminoirs, which is even stronger than the tempered glass of M. Bastie. The relative resistance to breakage of the two glasses is said to be as 5 to 3 in favour of Siemens' over Bastie's. The fracture of the latter is fibrous, whereas that of the former is crystalline. The strength of a plate of compressed glass is from seven to ten times stronger than a plate of ordinary glass. Experiments made before the Polytechnic Society of Berlin have shown that whereas a plate of ordinary glass, supported at its four corners in a horizontal position, was broken by the fall of a leaden ball 120 grammes in weight from a height of three decimetres, a similar plate of compressed glass was only broken when the ball fell from a height of three metres, or ten times as high. This corresponds to an energy of blow a hundred times greater in the case of the compressed glass.

ACTION OF COMPRESSED OXYGEN.—M. Bert has recently discovered that highly compressed oxygen has the power to destroy all living animal and vegetable organisms. Fermentations which are due to the presence of living growths are entirely checked by it, whereas fermentations due to dissolved matter, like diastase, successfully resist its influence. The ripening of fruits is arrested by exposure to compressed oxygen, but the poison of the scorpion, on the other hand, is unaffected by it. Fresh vaccine matter, subjected for over a week to oxygen at a pressure of fifty atmospheres, preserved its virtue, and there is therefore good reason for believing that the active principle of vaccine lymph is not due, as has been hitherto supposed, to living cells. The virus of glanders and carbuncular blood, freed from bacteria after being treated with compressed oxygen, were found to retain their powers of poisonous inoculation, and may therefore be classed along with vaccine matter. The theory which referred these blood poisons to germs has been severely shaken by M. Bert's important investigation.

AMONGST many interesting specimens of beautiful and celebrated trees exhibited in the parks and gardens of the Paris International Exhibition—myrtles and planes from Greece, lotuses from Egypt, date palms from Arabia, cypruses from Persia, and citrons from Monaco—there will be a section of a forest giant from

the Mississippi over 60 feet in circumference. It forms part of a trunk nearly 300 feet high, which was extracted from one of the floating islands of the Father of Waters.

MR. GIFFORD has in course of construction a large captive balloon to be in operation at the Paris Exhibition. It will be over 34 metres in diameter and is intended to raise 50 persons at a time to a height of 600 metres.

SUMMER Schools for science teaching and summer scientific excursions into the country are becoming very common in America. The late Professor Agassiz was the first to inaugurate them.

AN International Exhibition under the patronage of H.R.H. King Humbert is to be held at Milan in 1879. It has been organised by a National Committee, and the municipality of the city have granted the necessary site.

PREPARATION OF SPONGY PLATINUM.—Professor Böttger in a communication to the Physical Society of Frankfort, announces that spongy platinum may be prepared by adding a small quantity of double tartrate of soda and potassa to a solution of platinum chloride, and boiling the mixture. A violent evolution of carbonic acid takes place and all the platinum is deposited in a spongy form. It is then only necessary to dry the latter on filter paper.

VISIBLE SOUND-WAVES.—Mr. Sedley Taylor recently communicated to the Royal Society a process for making sound-waves visible to the eye. A hole cut in cardboard is glazed with a film of soap dissolved in glycerine, just thick enough to produce bands of colour. This is fixed to a tuning-fork, which is put into vibration by a violin bow, and immediately a series of rings and bands corresponding to the note of the fork are displayed on the film.

FIRE IN COAL SHIPS.—A new ship, the *Sandhurst*, 1,600 tons register, recently left Glasgow with a cargo of coals for Bombay, with a new machine on board for extinguishing fire. It consists of a large pump, worked by an engine and fed by a copper pipe from the sea; and it is estimated that 10,000 gallons of water can be raised and discharged by it in an hour. The pump is so arranged that when a quantity of water has been pumped into the hold on a burning cargo, the sea-cock can be closed and the water in the hold pumped up, so as either to be returned to the sea or discharged afresh over any part of the cargo. Arrangements are also made for testing the temperature of the cargo at different points during a voyage.

COAL TAR COLOURS.—Some little time ago considerable alarm was raised in France by the report that aniline dyes were freely employed for tinting the cheaper kinds of red wine. As those salts are all more or less poisonous, the uneasiness of the public was great, and many chemists set to work to discover tests for the suspected adulterations. Several ingenious modes of detection were the result, one being a test paper called Oenokrine, which, dipped in pure red wine should be greyish blue while wet, and lead coloured on drying; if aniline colours are present it turns carmine red; if elderberry juice, green; if logwood or Brazil wood, the colour of wine dregs; if indigo, a deep blue. The reported use of aniline dyes in wine turned out to be untrue. Aniline colours are, however, employed in water colour painting, a fact which is to be regretted, since although they yield tints far more vivid and true to nature than mineral pigments, they inevitably fade in a short time.

FOUCAULT'S PENDULUM EXPERIMENT.—The pendulum experiment made in 1860 at the Pantheon by the celebrated physicist, Leon Foucault, is well known. An enormous metallic globe or gyroscope, which hung from an iron wire attached to the summit of the vault, demonstrated that the oscillation of a heavy mass freely suspended in space at the extremity of a cord without torsion, would be independent of the rotation of the earth.

The pendulum swung very slowly because of the length of the wire, and at the end of each oscillation a projecting point on the bottom of the globe furrowed a little wall of sand so as to render the displacement of the path of the globe more easily perceptible.

It is intended, we learn from *La Nature* to repeat that experiment at the Paris Universal Exposition of 1878. It will be executed with new improvements, in such a way as to impress the mass of visitors.

The pendulum weighing about 300 kilogrammes will be made to oscillate at the extremity of an iron wire from 65 to 70 metres long. Thus a special building will be required for the apparatus. Under the pendulum will be placed an immense terrestrial globe from 25 to 30 metres in diameter. This globe, resting on the ground will, along with the spectators, necessarily accompany the movement of the earth. An arrangement of large hands or pointers actuated by the pendulum will exhibit the displacement of the latter due to the earth's rotation.

The globe which will represent the earth having a considerable volume, the movement of the hands will be quite visible, and in this way the least attentive person will be able to realize the rotation of the earth upon its axis.

PHOTOGRAPHY.—The rapid development of photography as an art, the fascinating nature of its pursuit, and its growing application to solar and stellar science, have swelled the ranks of its students to quite an army of amateurs and professionals. To these, Captain Abney's "Treatise on Photography" (Longman's "Text-book of Science" series) will be welcome as combining not only the best and most reliable practical directions, but the scientific explanation of the processes. The book begins

with a history of the rise of photography, then treats of the theory of sensitive compounds, the action of light upon them, and the materials and manipulation employed in the various kinds of processes. Next, follow chapters on the various printing processes of Swan, Johnson, Willis, Woodbury, Edwards, Albert, and others,—processes by which photographs are printed off like letter-press—and lastly, there are some instructive chapters on microscopic, celestial, and spectroscopic photography. Captain Abney's book is full of very useful information and treats the subject in a truly scientific as well as a comprehensive and practical manner.

SEA SEDIMENT.—The movement of large quantities of sediment in the sea has hitherto been commonly regarded as the result of wave motions; but another probable cause has recently been pointed out by M. Fuchs. This is the heaping up of the sea on the coast produced sometimes by the flood-tide and sometimes by the prevalence of high winds blowing in on the shore. The sea-level is frequently elevated from 10 to 30 feet in this way; and this disturbance of level originates a current from the points of great pressure, that is at the shore, to the points of lesser pressure out at sea. This current sweeping along the sea-bottom is capable of carrying, not only the fine detritus with it, but in some instances even the large boulders, and depositing them in the deeper parts.

MAKING SOFT ALLOYS SONOROUS.—Pewter, Britannia metal, and other such like soft metal alloys emit a dull lead-like sound on being struck; but by a process recently invented by Mr. B. Silliman, of New Haven, Con., U.S. they may be made sonorous. A bath of oil or paraffin is heated to a temperature from 5° to 5·5° below the melting point of the alloy to be treated. The exact point is determined in each case by heating the bath until a sample of the alloy suspended in it becomes ready to be stretched by a wire having a somewhat higher melting point. Small thin articles are then immersed in the bath for 15 or 30 seconds; larger articles, such as urns, are kept in a minute or more. It is essential that each article be heated uniformly, and great care is necessary in handling. The rate at which the articles may be allowed to cool is immaterial. The alloy is harder and stiffer after the process, but does not become porous. It can be soldered, plated, &c., but may not be hammered, pressed, &c., without impairing its sonorousness.

City Notes.

Old Broad Street, 28th February, 1878.

SIR JAMES CARMICHAEL did his best, at the meeting of the proprietors of the Submarine Telegraph Company, to smooth over the fact that there had been a decrease in the receipts of the concern. But he simply adopted the ground taken up in the report of the directors, repeating, in effect, that the falling off was due to the political and commercial state of Europe during the half-year ending December, 1877, and he did not enter into any particulars. We therefore remain in wonderment as to how it happens that while other companies have been doing better than usual in consequence of increased telegraphic traffic occasioned by the very political excitement which Sir James Carmichael deplores, the revenue of the Submarine Company has been declining. However, we do not wish to lay undue emphasis on the point. It is satisfactory to hear that the Company is likely to renew its traffic with France, and it must also be welcome intelligence to the shareholders to learn that the cables of the Company are in good working order, and that the expenditure for repairs for the last six months was less heavy than usual. We ought to have stated before that the dividend declared was *not* free of, but was less, income tax.

We suppose that the shareholders of the Mediterranean Extension Telegraph Company have no particular reason to be dissatisfied. Three per cent. is not a big dividend, but there might be no dividend; and there is nothing in the report to which exception can well be taken. But the question was very properly raised at the meeting whether the reserve fund really belonged to both the preference and the ordinary shareholders, or to the latter only, and as the reply of Mr. Ponsonby—who merely said that the fund was needed for relaying the cables required, and it was necessary that it should be kept in hand in order that the Company might retain the concession from the Italian Government—was rather beside the point, it was wisely decided by the meeting to submit the matter to the opinion of counsel. It will be interesting to learn what counsel think about it.

It is mentioned in the report of the Telegraph Construction and Maintenance Company, that during the past year the liquidation of W. T. Henley & Co., Limited, has taken place; but the Company hold a first mortgage on the estate and works and plant at North Woolwich, and the directors seem to think they have made such reserves as will cover any loss in dealing with the property. So far, that is satisfactory enough. The Company must have done a good business in 1877, for the total quantity of cable manufactured was 1,962 miles, and the total quantity laid 3,652 miles. After the dividend of fifteen per cent. is paid, there remains a balance of £61,247 to be carried forward.

It is announced by the Western and Brazilian Telegraph Company that the first annual drawing of its six debentures, will take place at the Company's offices on the 1st of March.

The directors of the West India and Panama Company have recently received a telegram stating that a new cable between Santiago de Cuba and Jamaica has been successfully laid. That section of the Company's system has thus been duplicated. We understand that the cable, which was manufactured by Messrs. Siemens Brothers, is in perfect electrical condition.

It is stated that a gentleman, whose name has for some years been before the public in connection with telegraphy, is about to receive the honour of knighthood. We have no idea how true or how false the rumour is, but should it be true, we shall be able to congratulate more than one of the telegraph companies on the distinction conferred upon their chairman. The old adage that "Nothing succeeds like success" is being constantly fulfilled, and if the gentleman in question gets a handle to his name, it will be one instance more.